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## Comparative investigation of marginal adaptation of mineral trioxide aggregate and other commonly used root-end filling materials

*Torabinejad M, Smith PW, Kettering JD, Pitt Ford TR. Comparative investigation of marginal adaptation of mineral trioxide aggregate and other commonly used root-end filling materials. J Endodon 1995;21:295-99.*

**PURPOSE:** To compare the marginal adaptation of MTA, amalgam, Super-EBA, and IRM, when used as root-end filling materials.

**M&M: Direct examination of original specimens:** 40 single-rooted teeth were cleaned, shaped, and obturated with GP and Roth's sealer. Following 3-mm root-end resections, cavities were prepared using a bur and were filled with one of the above materials. Following 48 h, all roots were longitudinally sectioned, prepared for SEM and examined. The distance between each filling material and the cavity walls was determined at standardized locations. **Resin replicas:** Another 48 teeth were similarly prepared, obturated and resected. 24 cavities were prepared with a bur whereas 24 were prepared using ultrasonics, again to a 3-mm depth. Each group of 24 was divided into 4 groups of 6, and filled with one of the test materials. After 48 h, Reprosil impressions of the filled root ends were made, and used to generate epoxy resin models. Replicas were examined under the SEM as above.

**RESULTS:** Original samples showed numerous artifacts (particularly, cracks and increased marginal gaps) in the longitudinal sections. MTA had significantly smaller gaps (ave  $2.68 \pm 1.35\mu$ ) than the other filling materials. No significant differences were found among amalgam, Super-EBA or IRM. By comparison with the originals, the resin replicas had no artifacts and demonstrated smaller gaps. The method of preparation (bur vs ultrasonic) had no effect on the gap sizes. None of the MTA-filled samples showed any noticeable marginal gap, being significantly ( $p < 0.01$ ) better adapted than the other materials. IRM displayed gaps in all specimens (ave  $8.37 \pm 4.61\mu$ ), which were significantly wider than amalgam.

**C&C:** This study adds to the steady accumulation of knowledge concerning MTA, all of which to this point has shown MTA to provide better adaptation and seal than other commonly used root-end filling materials. Further physical property and in vivo biocompatibility testing should certainly be performed before endodontists change materials. The methodology used herein is not foolproof - longitudinal saw-sectioning has strong potential to produce interface artifacts. Furthermore, Yoshimura et al. (1990) showed a lack of correlation between gap size and microleakage.

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Christopher F. Bates

## **A comparison of maintenance of canal curvature using balanced-force instrumentation with three different file types**

*Royal JR, Donnelly JC. A comparison of maintenance of canal curvature using balanced-force instrumentation with three different file types. J Endodon 1995;21:300-4.*

**PURPOSE:** To compare the ability of Flex-R (FR), K-Flex (KF), and nickel-titanium (NT) files to maintain root canal curvature in curved canals using balanced force (BF) instrumentation.

**M&M:** Forty-five extracted human molars with curved facial or mesial canals were used. Pre-operative radiographs were taken with a #15 KF file at working length (1 mm short of the apical foramen); radiographs were projected, tracings made, and canal curvatures measured using Schneider's method. All teeth were arranged in ascending order by degree of canal curvature and divided into 3 groups of 15, each group receiving every third tooth. Teeth were instrumented to a MAF #45 using the BF technique, Group A with NT files, Group B with KF files, and Group C with FR files. Post-operative radiographs were taken, canals were traced, and differences in canal curvature before and after instrumentation were analyzed statistically.

**RESULTS:** There were no statistically significant differences in before and after canal curvature changes between the KF and FR files, but significant differences did exist between NT and KF files and NT and FR files.

**C&C:** NT files were statistically better in maintaining original canal curvature using the BF technique than were KF or FR files.

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**Michael Hall**

## Endodontic retreatment with halothane versus chloroform solvent

*Wilcox LR. Endodontic retreatment with halothane versus chloroform solvent. J Endodon 1995;21:305-7.*

**PURPOSE:** To compare the gutta-percha (GP) removal ability of halothane and chloroform, and the time necessary to retreat (retx) using the two solvents.

**M&M:** 30 single-canal mandibular premolars were cleaned, shaped, obturated, and temporized with Cavit® prior to 14 months storage at 100% humidity. Two retx groups (15 teeth each) were randomly created, and the coronal third GP was removed with a #3 Gates Glidden drill, in order to form a reservoir. 2-3 drops of halothane or chloroform solvent were added. A #20 file was used to make space alongside the GP, and size #40 broaches were used to remove softened GP. Additional solvent was added as needed. Retx was deemed complete when no GP was evident on a paper point; retx time was recorded to the nearest minute. All teeth were longitudinally split, photographed, projected and analyzed using a sonic digitizer. Areas of the canal and remaining GP were individually measured at each coronal, middle and apical third.

**RESULTS:** There was no significant difference between chloroform and halothane retx in the amount of GP removed. Neither method completely removed GP from the root canals. The mean % of remaining GP (total area) with halothane was 16%, whereas that for chloroform was 12.1%. Retx with halothane was significantly slower ( $p = 0.0009$ ) than chloroform however, taking an average of 3.1 min longer. Minutes to retx averaged 7.7 min for chloroform and 10.8 min for halothane.

**C&C:** In deciding on a solvent for retx, a balance between the practicality of efficient use of time and necessity for safety must be struck. Chloroform may be faster; halothane may be safer. This study shows that neither is superior over the other in its ability to solvate GP, when a visual end point is used.

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## Comparison of concentric condensation technique with laterally condensed gutta-percha

*Page ML, Hargreaves KM, ElDeeb M. Comparison of concentric condensation technique with laterally condensed gutta-percha. J Endodon 1995;21:308-13.*

**PURPOSE:** To compare *in vitro* the sealing ability of concentric condensation (CC), with and without sealer, to lateral condensation (LC).

**M&M:** 62 mandibular premolars with straight canals and 62 mesial mandibular molar canals with curvatures greater than 20° were used. All canals were instrumented using the balanced-force technique. Pre- and postobturation radiographs were made for each premolar next to a step wedge. Six groups of 20 teeth were generated: Group 1 - premolar, LC with sealer; Group 2 - premolars, CC with sealer; Group 3 - premolars, CC without sealer; Group 4 - molars, LC with sealer; Group 5 - molars, CC with sealer; Group 6 - molars, CC without sealer. Sealer used was a ZOE without radiopacifiers. Following obturation, the teeth were tested in India ink for leakage for 14 days, dried, cleared, and the leakage measured to the nearest 0.1 mm. Radiographs were scanned at 2 mm and 6 mm from the apex to generate radiographic density curves of the gutta-percha. Gutta-percha extrusion and Micro-Flow Compactor (MFC) breakage was recorded. Mean leakage values between groups were compared using a two-way ANOVA, and the calculated density ratios were compared using a one-way ANOVA.

**RESULTS:** Analysis showed no significant difference in leakage between Groups 1, 2, 4, and 5 (all obturated **with** sealer; these groups were all significantly different from Groups 3 and 6 (the paper said 3 and 4), which were also significantly different from each other, with Group 3 showing the greatest leakage. There were no significant differences in radiographic densities at 2 mm or 6 mm from the apex between Groups 1, 2, and 3. No significant differences among the groups existed regarding gutta-percha extrusion, and size 30 MFCs broke more frequently than size 50s.

**C&C:** The authors describe CC as thermomechanical compaction with thermoplasticized gutta-percha using a type of condenser called a Micro-Flow Compactor, but no description of it is given nor credit for its development or efficacy. The results indicate that whether you obturate with LC or CC in straight or curved canals, sealer is important to minimize leakage (*in vitro*).

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## Root strains associated with different obturation techniques

*Saw L-H, Messer HH. Root strains associated with different obturation techniques. J Endodon 1995;21:314-20.*

**PURPOSE:** To compare the strain in tooth roots associated with three obturation techniques: lateral condensation (LC), thermoplasticized gutta-percha (GP) (Obtura), and Thermafil (TF).

**M&M:** 27 maxillary central incisors were partially decoronalized, and instrumented to a size #40-45 master apical file. Strain gauges were bonded to the apical and coronal thirds of each root. Each root surface with its attached apparatus was covered with 200  $\mu$  of silicone (to mimic the PDL), and embedded in stone. One operator randomly obturated 9 teeth with each technique, using AH26 sealer. Obturations were done on a balance, in order to measure the peak vertical load. Root distortion was recorded from each gauge using microcomputer software. Teeth from the LC and Obtura groups were then randomly divided into two groups: in one, GP was removed to the apical third level of the root, whereas in the other GP was removed to the coronal third. These roots were finally fractured with a #40 finger spreader, which was forced into the GP mass by a servohydraulic device. The applied load at failure was recorded.

**RESULTS:** The mean vertical condensation load was significantly lower for the TF group (0.92 kg) than LC or Obtura, which were similar (~ 2.5 kg). Thermal strain was found to be a large component of that caused by the Obtura and Thermafil techniques, and was sig higher at the more coronal location. The highest total (mechanical plus thermal) strains were generated by the Obtura technique, whereas there was little difference between LC and TF. The highest apical strains also occurred with Obtura. There was no significant difference in the loads at fracture between the apical third GP group and the coronal third group; a mean load of 16.1 kg was required to cause vertical root fracture (VRF). Most fractures were complete, occurred labiolingually, passed through the apical foramen, and occurred when the spreader reached the apical third of the root.

**C&C:** This study showed that the mean load required to cause VRF (in maxillary central incisors) was 5-6 times higher than the typical load used in obturation. Due to anatomical variability, some teeth will have weaker mechanical properties, however. Also, the method used for canal obturation may be less of a factor in causing a clinical VRF than how the canal is prepared, the use of post restorations or subsequent functional loading on the tooth.

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Christopher F. Bates

## Analysis of stress distribution in a vertically condensed maxillary central incisor root canal

*Yaman SD, Ala Ğam T, Yaman Y. Analysis of stress distribution in a vertically condensed maxillary central incisor root canal. J Endodon 1995;21:321-5.*

**PURPOSE:** To analyze the stress distribution in a maxillary central incisor, assumed to be filled via vertical condensation, using a 3-D finite-element method (FEM).

**M&M:** Using a geometric model of a vertically condensed, filled root canal of a central incisor with variable cross-sectional areas, assumed to be present in anterior teeth, a 3-D FEM was used to determine stress distribution. The root canal model was considered to be composed of 8 vertical sections corresponding to the application of vertical condensation in 8 successive steps starting at the apex. For each condensation step, vertical loading caused by spreader application is assumed to act over the whole cross-sectional area.

**RESULTS:** Three cases were selected for analysis: the first two represented canals filled one-third and two-thirds the way from the apex, and the third represented a totally filled canal. Determined stress values indicated that built-up stresses accumulated during successive vertical condensation stages are not so great as to cause failure (vertical root fracture).

**C&C:** Not being an aeronautical engineer or Turkish, I found this article very difficult to decipher. I believe their point was to show that FEM is a good method for studying biomechanical problems as compared with photoelastic or other mechanical means of determining stress distributions. Also, I think they wanted to show that vertical condensation of GP does not appreciably result in excessive stress on remaining dentin.

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**Michael Hall**

## Radiovisiography versus conventional radiography for detection of small instruments in endodontic length determination. Part 1. In vitro evaluation

*Ellingsen MA, Harrington GW, Hollender LG. Radiovisiography versus conventional radiography for detection of small instruments in endodontic length determination. Part 1. In vitro evaluation. J Endodon 1995;21:326-31.*

**PURPOSE:** To compare the ability of the radiovisiography (RVG) and conventional radiography (CR) to identify size #8 and #10 endodontic file tips in relation to the radiographic apex.

**M&M:** Size #8 or #10 K-type files were inserted into the mesiobuccal roots of 25 maxillary molars, until flush with the apical foramen. Kodak D- and E-speed film was used for CR; radiographs were viewed using  $\times 2$  magnification. RVG images were altered to allow several views: original unenhanced, enhanced, negative-to-positive conversion, and the zoom feature in both the standard and in the negative-to-positive modes. Each of the 5 RVG images was compared with the 2 CR images for detail and visibility of the file tip in relation to the apex by two evaluators. D- and E-speed radiographs were similarly compared.

**RESULTS:** Zoom in the negative-to-positive mode was statistically equivalent to D-speed radiographs and superior to E-speed radiographs. D-speed film was superior to the other RVG views. The standard zoom was also superior to E-speed radiographs. D-speed radiographs were statistically superior to E-speed radiographs, being judged better than E-speed 90% of the time. Accurate identification of the position of the file tips was achieved on all D- and E-speed radiographs with the use of magnification. Evaluators exhibited high agreement.

**C&C:** Broad mesiobuccal roots, such as those used in this study, tend to obscure the tips of small files on radiographs. Enlarging canals to a minimum of size #15 before canal length determination certainly carries the potential to ledge or be blocked out. The authors have shown (although somewhat subjectively) RVG clarity of smaller file tips to be equivalent to D-speed radiographs, when used in the negative-to-positive/zoom combination mode. Additionally, D-speed images were judged superior in clarity to the E-speed radiographs, yet both allowed accurate localization of the #8 or #10 file tip, when used with magnification. Clinically, superimposition of soft tissues and alveolar bone, as well as the effects of scattered radiation, might prevent discrimination of small file tips.

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## Effects of vacuuming on dye penetration patterns in root canals and glass tubes

*Masters J, Higa R, Torabinejad M. Effects of vacuuming on dye penetration patterns in root canals and glass tubes. J Endodon 1995;21:332-4.*

**PURPOSE:** To compare the degree of dye leakage of filled and unfilled glass tubes with that of filled and unfilled prepared root canals.

**M&M:** Forty glass tubes, lumen diameter 0.5 mm and length 12 mm, and 40 calcified root canals of single-rooted anterior teeth, were used. The root canals were prepared to a lumen diameter of 0.5 mm with #50 Canalmaster-U files. The coronal ends of the root canals and one end of the glass tubes were sealed with 2 mm of Cavit. Both root canals and glass tubes were divided into 2 groups of 20 of filled and unfilled specimens, and these were then subdivided into those subjected to vacuum pressure and those not vacuumed. Non-vacuumed specimens were passively submerged in methylene blue dye for 72 hours; vacuumed specimens were placed in a flask connected to a vacuum pump which applied a pressure of 25 mm Hg for 3 minutes, after which dye was added to the flask. Roots were longitudinally sectioned before measuring dye leakage with a dissecting microscope.

**RESULTS:** The glass tubes with or without vacuuming leaked 17% or less of their lengths. The filled glass tubes averaged 70.5% leakage, and the 10 with vacuum had 100% leakage. Unfilled root canals had a mean leakage of 74% without vacuum and 91% with vacuum. Filled root canals had a mean leakage of 95.5% without vacuum and 100% with vacuum.

**C&C:** Prepared root canals, whether filled or unfilled, leaked significantly more than glass tubes in this study. The absence of GP resulted in incomplete dye penetration, possibly due to the greater capillary action with decreasing lumen size as the canal is obturated. No significant difference in dye penetration was found in obturated root canals with or without vacuum, suggesting that the use of vacuum in dye leakage studies may not be necessary.

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**Michael Hall**

## **Influence of operator proficiency on the sealing ability of the vertical condensation**

*Dagher FB, Yared GM. Influence of operator proficiency on the sealing ability of the vertical condensation. J Endodon 1995;21:335-6.*

**PURPOSE:** To compare, over a long-term basis, the quality of the apical seal obtained after vertical condensation performed by three operators with different levels of competency in the technique.

**M&M:** 90 anterior teeth were cleaned and shaped to a size #30 file at working length, and flared with reamers and Gates Glidden drills. Fine-medium gutta-percha (GP) cones were fitted at 1.0 mm short of the WL, and sized Machtou pluggers were trial-fitted so as to not contact canal walls. The teeth were divided into three groups of 30, each of which were obturated with vertical condensation and Pulp Canal Sealer® by one operator. Operator groups had increasing levels of proficiency: A-general dentist; B-graduate endodontic resident; and C-experienced endodontist. Microleakage of the samples was determined by the fluid filtration method (10 psi) at 1.5 h, 1 d, and 1, 4, 12, 18, and 24 wk after obturation.

**RESULTS:** There was a trend toward increased microleakage over time for the three groups. Group A (condensed by the inexperienced operator) showed significantly ( $p < 0.005$ ) greater microleakage at all time intervals than groups B and C. Microleakages for groups B and C were similar through the 1st day; however, that for the endodontist was sig less than that for the resident thereafter.

**C&C:** The results of this study showed that individual competence in the vertical compaction of warm GP can influence the quality of the apical seal. The authors speculate that the less competent operators may have been nonrhythmic and delayed in their delivery of the heat source and the packing procedure. If apical accumulation of heat was not accomplished, condensation might be less efficient.

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**Christopher F. Bates**

## Vertical root fracture in nonendodontically treated teeth

*Yang S-F, Rivera E, Walton R. Vertical root fracture in nonendodontically treated teeth. J Endodon 1995;21:337-9.*

**CASE REPORT:** Eleven Chinese patients with 12 molars that developed vertical root fractures (VRF) are reported. None of the molars were endodontically treated. Widening of the canal space as seen on radiographs led to the suspicion of VRF. All patients were male, ages 56 to 71. Patients' complaints ranged from none to thermal sensitivity, biting pain, and continuous pain. Eleven teeth were extracted and showed classic signs of VRF: confined to the roots, extending from canal to root surface, and oriented in a B-L plane. Eleven fractured roots involved mesial canals of mandibular 1st molars and one was a MB canal of a maxillary 2nd molar.

**C&C:** VRF in teeth not endodontically treated has not been reported in the Western literature, and may be confined to certain populations such as the Chinese in this study. Etiology is uncertain, but may be related to diet pattern and habits; occlusal attrition was generally found in this population. However, definite conclusions cannot be made as to the cause of these VRFs. In any event, spontaneous VRF evidently can occur.

**June 1995**  
**Hall**

**Michael**

## Avoiding the mental foramen during periapical surgery

*Moiseiwitsch JRD. Avoiding the mental foramen during periapical surgery. J Endodon 1995;21:340-2.*

**PURPOSE:** To present several techniques to decrease the risk of an unfavorable outcome following periapical surgery in proximity to the mental foramen (MF).

**DISCUSSION:** *Preoperative diagnosis* - Standard angle periapical radiographs rarely show the vertical position of the MF. Although very acceptable, panoramic radiography is not available to many endodontists. An alternative technique is to use a vertically placed standard film in conjunction with local anesthetic and a paralleling device. *Flap design* - When treating a tooth distal to the MF, triangular flaps with mesial releasing incisions cause the mental nerve to be stretched within the bed of the flap. A releasing incision placed distal to the surgical site will achieve good access without reflecting the mental nerve at all. Injury to either the inferior labial branch of the facial artery or the long buccal nerve are unlikely. *Surgical technique* - Nerve damage as a result of adjacent surgery typically occurs due to stretching or crushing, and rarely by a clean surgical cut. To prevent retractor slippage against the bone and subsequent neurovascular damage, grooving the bone will create a positive location for retraction. Grooving is done at the approximate level of the apex, yet coronal to the MF.

**C&C:** The author presents three simple and worthy clinical tips to consider when performing mandibular periapical surgery in or around the mental foramen. When combined with other surgical precautions, safety to the mental neurovascular bundle is potentially enhanced. These alternatives might be applied to other teeth in the jaws, in certain circumstances.

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